Kinetics and thermodynamics of synthesis of palm oil-based trimethylolpropane triester using microwave irradiation

ABSTRACT

Enhancement of reaction performance utilizing microwave irradiation has drawn so much interest due to its shorter reaction time and low catalyst loading. These advantages are particularly significant from kinetics and thermodynamics perspectives. This study aimed to investigate the kinetics and thermodynamics of microwave-assisted transesterification of palm oil-based methyl ester into biolubricant. The transesterification reaction of palm oil methyl ester (PME) and trimethylolpropane (TMP) was conducted at 110–130 °C for 90 min under vacuum condition. Sodium methoxide was employed as the catalyst at 0.6 wt% of reactants fixed at molar ratio of 4:1 (PME: TMP). The experimental data were fitted with the second-order reversible reaction kinetics mechanisms. The data were solved via Runge-Kutta 4,5 order using MATLAB software. Analysis on the data revealed that the reaction rate constants at temperatures of 110–140 ℃ were in the range of 0.01–0.63 [(w/w)(min)]−1, with standard errors of 0.0026–0.0228 within 99.99% prediction interval. Microwave-assisted reaction obtained 17.0 kcal/mol of activation energy. This method reduced activation energy by 49% as compared to the conventional heating. Activation energy and time-periodic energy assessment showed that the reaction was endothermic. The reaction at 130 °C is the easiest to activate. The positive Gibbs free energy ($\Delta G > 0$) found using Eyring-Polanyi equation indicated that the transesterification was non-spontaneous and endergonic.

Keyword: Antarctica; Bacteria; Diesel; Heavy metal; Marine